

## **Safety Note**

---

### **Safety Note Number**

---

### **Title**

Date: \_\_\_\_\_

Written By: \_\_\_\_\_

Responsible Individual Signature \_\_\_\_\_

Please Print Name \_\_\_\_\_

Division/Group/ section \_\_\_\_\_

Pressure Consultant Signature \_\_\_\_\_

Please Print Name \_\_\_\_\_

Division/Group/ section \_\_\_\_\_

Division Leader Signature \_\_\_\_\_

Please Print Name \_\_\_\_\_

Division/Group/ section \_\_\_\_\_

**Distribution:**

Engineering Records Center ERC L- 118

Pressure Safety Manager L-383

Responsible Individual L-

Pressure Consultant L-

Division Leader L-

System Users L-

Interested Parties L-

ES&H Safety Team L-

**A. Description:****B. Hazard**

## **C. Calculations:**

**Liquid: PdV mechanical work**

$$E = \frac{P_1^2 V}{2B}$$

**Gas: Isentropic expansion of a confined gas**

$$E = \frac{P_1 V_1}{K-1} \left[ 1 - \left( \frac{P_2}{P_1} \right)^{\frac{K-1}{K}} \right]$$

**Where:** E = stored energy                      K = ratio of specific heats

P<sub>1</sub> = MAWP                              V = volume

P<sub>2</sub> = atmospheric pressure              B = liquid bulk modulus

## **C. Calculations (continued)**

stored energy (E) = \_\_\_\_\_

MAWP (P1) = \_\_\_\_\_

atmospheric pressure (P2) = \_\_\_\_\_

ratio of specific heats (K) = \_\_\_\_\_ Values can be found in reference section H.

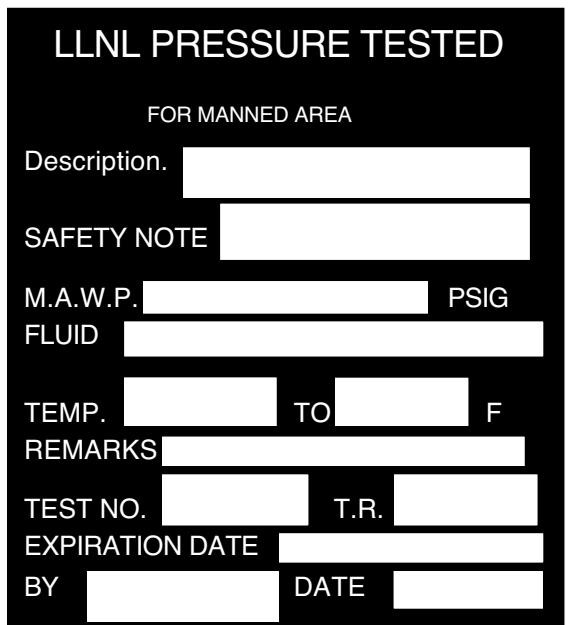
volume (V) = \_\_\_\_\_

liquid bulk modulus (B) = \_\_\_\_\_ Values can be found in reference section H.

The equations need to be adjusted for proper consistent units and values. See appendices for TNT stored energy equivalents. ie  
Ft.lbs. divided by 3420 = grams of TNT .

**D. Pressure Testing:****E. Re-test/Re-inspection:****F. Labeling:**

Description  
Safety Note  
MAWP  
Fluid                    Temp.  
Test No.  
Expiration Date

**G. Associated Procedures:**

## H. References:

**Table 24. Properties of Various Gases**

(Approximate values<sup>a</sup> at 68°F and 14.7 psia)

From Mark's Standard Handbook for Mechanical Engineers

Gas	Symbol	K = Cp/Cv
Acetylene (ethyne) .....	C <sub>2</sub> H <sub>2</sub>	1.30
Air .....	—	1.40
Ammonia .....	NH <sub>3</sub>	1.32
Argon .....	A	1.67
N-Butane .....	C <sub>4</sub> H <sub>10</sub>	1.11
Butene-1 (Butylene α) .....	C <sub>4</sub> H <sub>8</sub>	1.11
Carbon dioxide .....	CO <sub>2</sub>	1.30
Carbon monoxide .....	CO	1.40
Chlorine .....	Cl <sub>2</sub>	1.33
Ethane .....	C <sub>2</sub> H <sub>6</sub>	1.22
Ethyl chloride .....	C <sub>2</sub> H <sub>5</sub> Cl	1.13
Ethylene .....	C <sub>2</sub> H <sub>4</sub>	1.22
Freon (F-12) .....	CCl <sub>2</sub> F <sub>2</sub>	1.13
Helium .....	He	1.66
Hydrogen .....	H <sub>2</sub>	1.41
Hydrogen chloride .....	HCl	1.41
Hydrogen sulphide .....	H <sub>2</sub> S	1.30
Isobutane (2-Methyl propane) ...	C <sub>4</sub> H <sub>10</sub>	1.11
Methane .....	CH <sub>4</sub>	1.32
Methyl chloride .....	CH <sub>3</sub> Cl	1.20
Natural gas <sup>b</sup> .....	—	1.27
Neon .....	Ne	1.64
Nitric oxide .....	NO	1.40
Nitrogen .....	N <sub>2</sub>	1.41
Nitrous oxide .....	N <sub>2</sub> O	1.31
Oxygen .....	O <sub>2</sub>	1.40
Pentane .....	C <sub>5</sub> H <sub>12</sub>	1.06
Propane .....	C <sub>3</sub> H <sub>8</sub>	1.15
Propene (propylene) .....	C <sub>3</sub> H <sub>6</sub>	1.14
Sulphur dioxide .....	SO <sub>2</sub>	1.26
Sulphur hexafluoride .....	SF <sub>6</sub>	1.08

<sup>a</sup> Approximate values listed are adapted from the following sources: "CAGI Handbook." Rose and Rose, "Condensed Chemical Dictionary," Reinhold. "Handbook of Chemistry and Physics," Chemical Rubber Publishing Co. Selected Values of Physical and Thermodynamic Properties of Hydrocarbons and Related Compounds, *API Research Project 44*, 1953. Selected Values of Chemical Thermodynamic Properties, *NBS Circ.* 500, 1952.

<sup>b</sup> Representative value; exact characteristics require knowledge of exact constituents.

In general, for any amount of gas, the ideal gas equation becomes  
 $pV = NMRT$

*P = pressure, V = Volume, N = Number of moles of gas in the volume, M is the molecular Weight, R = Ru/M. MR in Lb. Ft is 1,546. One pound mole of any perfect gas occupies a volume of 359 cu. Ft. at 32 degrees F and 1 Atmosphere.*

**From Mark's Standard Handbook for Mechanical Engineers, NINTH EDITION**  
**Table 3.3.2 Bulk Modulus of Elasticity, Ratio of Specific Heats of Liquids**

Liquid	E in lbf/in <sup>2</sup> (6,895 N/m <sup>2</sup> )		
	Isothermal E <sub>r</sub>	Isentropic E <sub>s</sub>	k = c <sub>p</sub> /c <sub>v</sub>
Alcohol, ethyl <sup>a,e</sup>	130,000	155,000	1.19
Benzene <sup>a,f</sup>	154,000	223,000	1.45
Carbon tetrachloride <sup>a,b</sup>	139,000	204,000	1.47
Glycerin <sup>f</sup>	654,000	719,000	1.10
Kerosene <sup>a,e</sup> spl grl 0.81	188,000	209,000	1.11
Mercury <sup>e</sup>	3,590,000	4,150,000	1.16
Oil, machine, <sup>f</sup> sp.gr.0.907	189,000	219,000	1.13
Water, fresh <sup>a</sup>	316,000	319,000	1.01
Water, salt <sup>a,e</sup>	339,000	344,000	1.01

SOURCES: Computed from data given in:

<sup>a</sup> "Handbook of Chemistry and Physics," 52d ed., Chemical Rubber Company, 1971-

1972.

<sup>b</sup> "Smithsonian Physical Tables," 9<sup>th</sup> rev. ed., 1954.

<sup>c</sup> ASTM-IP, "Petroleum Measurement Tables."

<sup>d</sup> "Steam Tables," ADME, 1967.

<sup>e</sup> "American Institute of Physics Handbook," 3d ed., McGraw-Hill, 1972.

<sup>f</sup> "International Critical Tables," McGraw-Hill.

## Appendices:

### Appendix A

## TNT Stored Energy Equivalents

<b>multiply by to obtain</b>	<b>Joules</b>	<b>Mega Joules</b>	<b>Ft. Lbs.</b>	<b>Grams TNT</b>	<b>KGrams TNT</b>	<b>Lbs. TNT</b>
<i>Joules</i>		$10^6$	1.356	$4.638 \times 10^3$	$4.638 \times 10^6$	$2.107 \times 10^6$
<i>Mega Joules</i>	$10^6$		$1.356 \times 10^{-6}$	$4.638 \times 10^{-3}$	4.638	2.107
<i>Ft. Lbs.</i>	$7.376 \times 10^{-1}$	$7.376 \times 10^5$		$3.42 \times 10^3$	$3.42 \times 10^6$	$1.55 \times 10^6$
<i>Gram TNT</i>	$2.157 \times 10^{-4}$	$2.157 \times 10^2$	$2.924 \times 10^{-4}$		$10^3$	454
<i>KGrams TNT</i>	$2.157 \times 10^{-7}$	0.216	$2.924 \times 10^{-7}$	$10^{-3}$		0.454
<i>Lbs. TNT</i>	$4.746 \times 10^{-7}$	0.474	$6.45 \times 10^{-7}$	$2.2 \times 10^{-3}$	2.2	